Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/244
UNITED STATES
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

CORROSION IN LIQUID METAL SYSTEMS

David H. Gurinsky (Brookhaven National Laboratory)
J. R. Weeks (Brookhaven National Laboratory)
C. J. Klamut (Brookhaven National Laboratory)
L. Rosenblum (National Aeronautics Space Agency)
J. H. DeVan (Oak Ridge National Laboratory)

Liquid metal corrosion investigations have been stimulated in the last few years by the development of fast reactors and the interest in space power. In the latter applications, liquid metals are considered for use not only in reactors but also in power conversion systems. This paper presents corrosion data obtained in liquid and boiling liquid metal systems contained both in conventional materials of construction and in the refractory alloys.

Although there has been a general increase in the understanding of corrosion mechanisms the most important advance in recent years has been the recognition of the role of O_2, C, N_2, H_2 in corrosion by liquid metal coolants. In the liquid alkalis these elements often cause the observed physical property changes and corrosion. Analytical techniques for the determination of these elements in liquid metal systems have been improved to permit careful study of their effects. Also the requirements of environmental control to minimize contamination of refractory metals have been defined.

The liquid metals currently being studied are Li, Na, K, Rb, Cs, Hg, and the Pu 2.5 w/o Fe eutectic.

Lithium leaches Ni and most non-metallics from its containment at high temperatures. Attack of refractory alloys is highly sensitive to O activity in the solid, but not in the liquid metal: Cb-1Zr resists the attack observed on unalloyed Cb. Nitrogen in Li increases the solubility, and therefore the rate of attack of Fe, Cr, Ni, Ti, Mo, and Cb.

Sodium can be contained at temperatures up to 600C in the austenitic stainless steels; above this temperature Ni and chromium are leached. Na has been contained in Cb-1Zr up to 1200C. Above 600C Cb-1Zr removes oxygen from Na containing more than 5 ppm oxygen and is embrittled. Although carbon transport by Na is well known, its complex chemistry is only now being understood.

Potassium is less aggressive to austenitic stainless steels than sodium at temperatures up to 850C. At 1000C Cr and C co-transfer; however nickel is not leached. Hot trapped K does not attack Cb-1Zr up to 1100C. However, the behavior of oxygen in K is more complex than in Na.

Rubidium tends to leach Zr from Cb-1Zr and Ti from Mo-0.5% Ti at 1100C. At 925C these alloys as well as V and Haynes-25 are not attacked. Oxygen accelerates attack by spinel formation.

Isothermal transfer through Cs of both interstitial and metallic constituents of refractory alloys has been observed at temperatures above 1000C.

Ferritic steels and Haynes-25 corrode at low rates in boiling Hg systems at 600-650C. Zirconium is slightly better than Ti as a dissolved corrosion inhibitor. Mercury leaches Ni from austenitic stainless steels. Columbium is corrosion resistant to Hg; cold worked Cb-Zr alloys are susceptible to embrittlement at temperatures above 600C.

Plutonium-iron eutectic reacts with interstitial impurities in Ta capsules at temperatures $\geq$ 625C, resulting in a penetration of the Ta similar to the attack by Li on oxygen-contaminated Cb.